

Problems associated with the presence of organic solvent in flame retarded engineered thermoplastics is discussed in the background of the application (page 3, lines 6-10):

The compositions obtained according to its teachings are defective because the flame retardant is prepared in an organic solvent and therefore necessarily contains a significant amount of organic volatiles. **These volatiles cause metal corrosion and failure of metallic parts** which are near to or in close contact with the flame-retarded engineering thermoplastics.

Therefore it would be clear for an average skilled person in the art that one of the issues to be solved by the present application is the production of a flame retardant that contains only traces amount of residual organic solvents in order to minimize its corrosive effect.

It is known in the art that reducing the amount of residual organic solvents in high molecular weight brominated epoxide (HMW BE) is a difficult task, as disclosed in the application (page 2 line 33 to page 3 line 2).

Low Molecular Weight (LMW) BEs have low viscosity and therefore it is relatively easy to reduce the volatile content to very low levels by using equipment which is known to those skilled in the art. On the other hand, HMW BEs are very viscous, even at higher temperatures, and **it is therefore very difficult to reduce the volatile content to very low levels.**

This allegation is clearly supported by Example 3 of the application, wherein the Inventors demonstrate that it is almost impossible to reduce residual organic solvents to very low levels in HMW BE (1900 ppm of dioxane remains after 25 hours of vacuum drying, when dioxane has been used as a solvent during the process).

The present application proposes an alternative method to produce flame retardant based on HMW BE, containing only traces amounts of residual organic solvents. This method has **two essential features**: 1) the preparation of low molecular weight brominated epoxide (LMW BE) having a very low amount of organic volatile content (below 100 ppm); and 2) the absence of solvent in the reaction mixture when synthesizing HMW BE (page 4, lines 18-23).

Another aspect of the invention is a method for preparation the HMW BEs. Said method comprises the steps of reacting low molecular weight brominated epoxide (LMW BE), **having low volatile content**, with tetrabromobisphenol-A (TBBA) and tribromophenol (TBP) in the presence of a catalyst. The molecular weight of the LMW BEs is between 650 and 3,500 Dalton. The reaction takes place **without any solvent** at a temperature of 100 to 250°C, preferably 100 to 200°C.

The method of the invention is clearly exemplified in Example 1, and leads to a final product having as low as 13 ppm (0.0013 % !) of residual organic solvent without comprising any step directed to the removal of organic solvent from the reaction mixture. Conversely Examples 2 and 3 demonstrate that if one of the above features is not respected, the final flame retardant contains more organic solvent (290 ppm and 1900 ppm respectively).

None of the publications cited by the Examiner teaches or suggests the preparation of low molecular weight brominated epoxide (LMW BE) having a very low amount of organic volatile content, as a step to obtain HMW BE with a very low organic volatile content. Therefore, instant claim 22 should be acknowledged as being inventive over the cited prior art.

However, in order to further distinguish the present invention from Nakai and Nantaku, it has been explicitly specified in claim 22 that the method of the invention does not include any step of solvent removal, which would have been costly and time consuming. The precise process of the present invention can be clearly appreciated by the man skilled in the art reading Example 1 in the application as filed.

Surprisingly, it has been also discovered by the inventors that flame retardants having a low organic volatile content (below 100 ppm) also provide, to the thermoplastic polymer in which they are incorporated into, other original features such as an increased melt flow index (page 5 lines 7-13).

The polymeric compositions of the invention have a higher melt flow index and a lower melt viscosity, even under long residence time at high processing temperatures, than compositions containing comparable unmodified BEs. This property is particularly important in the production of objects with glass reinforced engineering plastics such as PBT, PET, or polyamides, as usually very thin walls and light weights are targeted. The high molecular weight flame retardant also contributes to the high processing heat stability needed for these types of products.

This feature is clearly exemplified in Table II (pages 11-12) and Table III (pages 12-13) of the application as filed.

Conversely, most of the examples of fire-retarded thermoplastics disclosed either in Nakai or in Nantaku show only poor flowability (up to 15g / 10 min in Nakai in example 1, and up to about 3g / 10 min in Nantaku as shown in Table II). In the present application, the very low amount of solvent obtain in the fire retardant of the invention, enables to obtain eventually fire-retarded thermoplastics with a flowability as high as 33 g/ 10min (after 5min residence time) and even 44 g/ 10 min (after 30 min residence time) [see Table II].

The above results further evidence the advantage of the present invention over Nakai and Nantaku, and its non-obviousness.

Claim Rejections – 35 USC §102 /§103

3. Claims 1, 3-4, 6-10, and 21 are rejected as anticipated by or, in alternative, as obvious over Nantaku et al. (JP 2001-310990). The Applicant respectfully traverses the Examiner's objection.

The Examiner alleges, on page 8 of the Office Action, that, while the method of making the flame retardant [in Nantaku] is not the method claimed in instant claim 22, this is a product by process claim. Product by process claims are not limited to the manipulations of the recited steps, only the structure implied by the steps. It is the position of the Office that the flame retardant made by the process of claim 22 is the flame retardant recited in Nantaku et al.

The Examiner adds that, alternatively, the flame retardant of Nantaku et al. is so close in structure and function to the flame retardant made by claim 22 that a person having ordinary skill in the art would expect them to have the same properties.

The Applicant strongly disagrees with the Examiner's allegations. Indeed, Nantaku discloses a flame retardant comprising high molecular weight brominated epoxides but having different properties. This is due to the fact that no requirement is made for an amount of less than 100 ppm of solvent is, contrary to the instant invention.

All the examples of Nantaku et al. discloses:

- 1) the addition of 600g dioxane (solvent) in the reaction mixture; and
- 2) the use of LMW BE used as raw without any particular interest as to the content of organic solvent.

However, the absence of solvent and a content of less than 100 ppm of organic solvent in the LMW BE are critical conditions to obtain a flame retardant as disclosed in the present invention.

Therefore, the flame retardant resulting from the process of the invention is radically different than the one of Nantaku as it contains less than 100 ppm of residual organic solvent.

Nantaku suggests removing the solvent by vacuum drying (see synthetic example 1). However, it is known to the person skilled in the art and was also demonstrated in the present application (see Example 3 of the application) that reaching the desired low content of organic solvent by this procedure is almost impracticable. This is one of the major issues addressed in the present application.

Moreover, it has been discovered by the inventor that the flame retardants of the invention also provide an increased melt flow index (better flowability) to the thermoplastic polymers in which they are incorporated into (page 5 lines 7-13).

All the examples of fire-retarded thermoplastics disclosed in Nantaku show very poor flowability (up to about 3g / 10 min as shown in Table II). In the present application, the very low amount of solvent obtain in the fire retardant of the invention, enables to obtain eventually fire-retarded thermoplastics with a flowability as high as 33 g/10min (after 5min residence time) and even 44 g/ 10 min (after 30 min residence time) [see Table II].

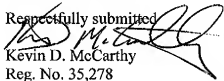
The allegation of the Examiner, suggesting that vacuum drying can enable reaching a content as low as 100 ppm of organic solvent in the flame retardant, is rebutted by the common knowledge in the art, as well as the demonstration of example 3 in the present application, and by the poor flowability results obtained by the thermoplastics of Nantaku.

Therefore, it is submitted that claims 1, 3-4, 6-10, and 21 are all novel and inventive in view of Nantaku.

Conclusion

4. The instant invention provides a method for preparing a flame retardant for engineered thermoplastics, said retardant conferring additional advantageous properties such as decrease of the corrosive effect and increase in flowability. Following the above explanations and the effected amendments, it is the Applicant's belief that the invention, as described in the amended claims, is novel and non-obvious over all the cited documents, and that the amended claims are ready for allowance.

Respectfully submitted


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